Complete 5-years time series of combined monthly gravity field models derived from Swarm GPS data

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Multi-approach gravity field models from Swarm GPS data

- ESA/DISC funded project (since 9/2017)
- Provide highest-quality monthly-independent Swarm gravity field models
- Combine individual gravity solutions, computed with:
  - different kinematic orbit solutions
  - different inversion approaches
- Monthly combined Swarm gravity field models:
  - from Dec. 2013 to Sept. 2018
  - available from:
    - ICGEM (http://icgem.gfz-potsdam.de/series)
    - ESA (https://earth.esa.int/web/guest/swarm/data-access, soon)

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Kinematic orbit solutions

- TU Delft: **GPS High precision Orbit determination Software Tool** (GHOST) Helleputte (2004); Wermuth et al. 2010
- AIUB: **Bernese** v5.3 Dach et al., (2015); Jäggi et al. (2007)
- IfG: **Gravity Recovery Object Oriented Programming System** (GROOPS) Zehentner et al. (2016)

Gravity field estimation approaches

- AIUB: **Celestial Mechanics Approach** (CMA), Beutler et al. (2010)
- ASU: **Decorrelated Acceleration Approach** (DAA), Bezdek et al. (2014); Bezdek et al. (2016)
- IfG: **Short-Arc Approach** (SAA), Mayer-Gürr (2006)
- OSU: **Improved Energy Balance Approach** (IEBA), Shang et al. (2015)

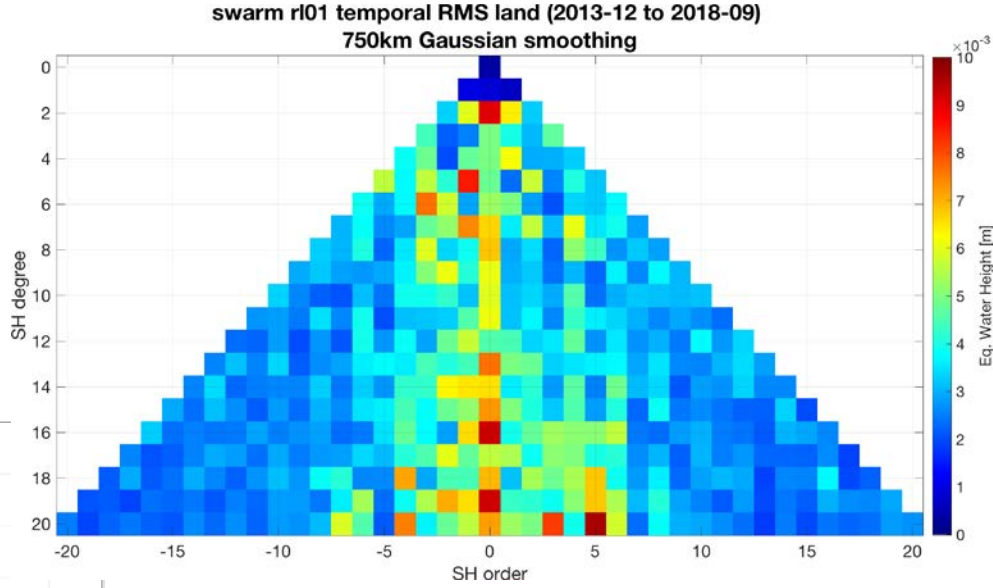
Combination of individual gravity field solutions

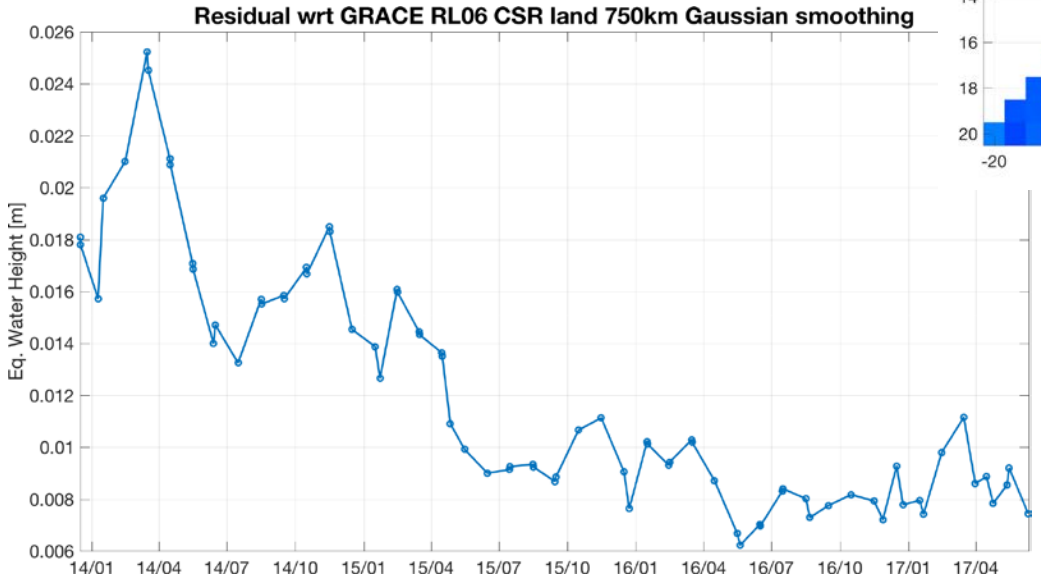
- Combination at the level of solutions, up do degree 40
- Weights derived from Variance Component Estimation (VCE)
- Degrees 2-20 considered in VCE
- Combination at the level of Normal Equations was tested but has slightly larger discrepancies w.r.t. GRACE (not shown)

Gravity field model pre-processing

- Truncation to degree 40
- C_{20} replaced with value from *GRACE Technical Note 11*
- Temporal variations relative to static GGM05G (GRACE and GOCE)
- Gaussian smoothing with 750-km radius (unless noted)
- GRACE CSR RL06 considered (with same pre-processing)
- GRACE and Swarm solutions interpolated to the union of both time domains (identical for all scenarios)

Agreement with GRACE over Land areas





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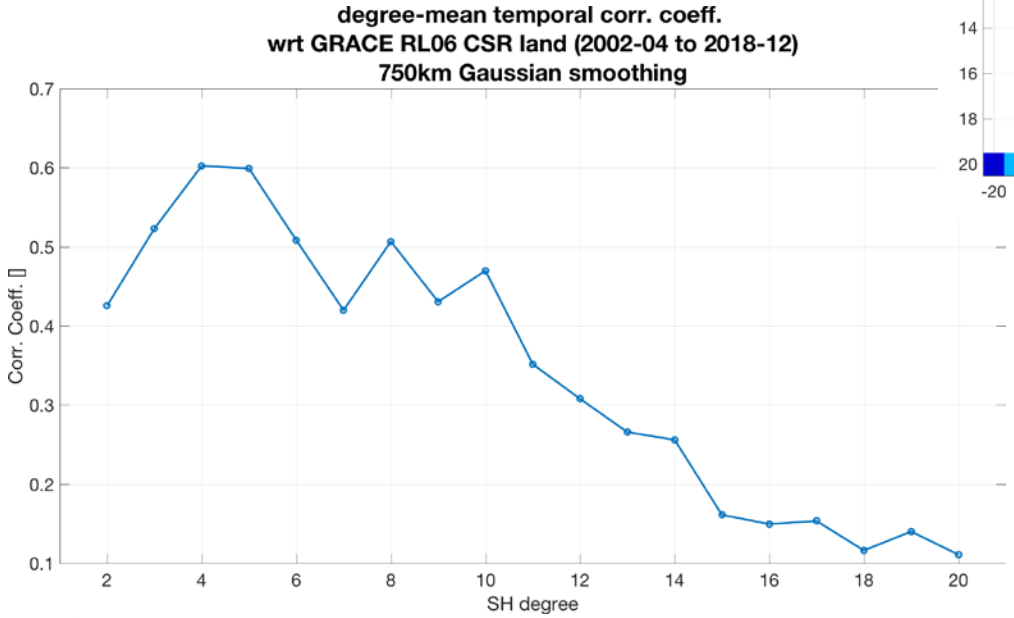

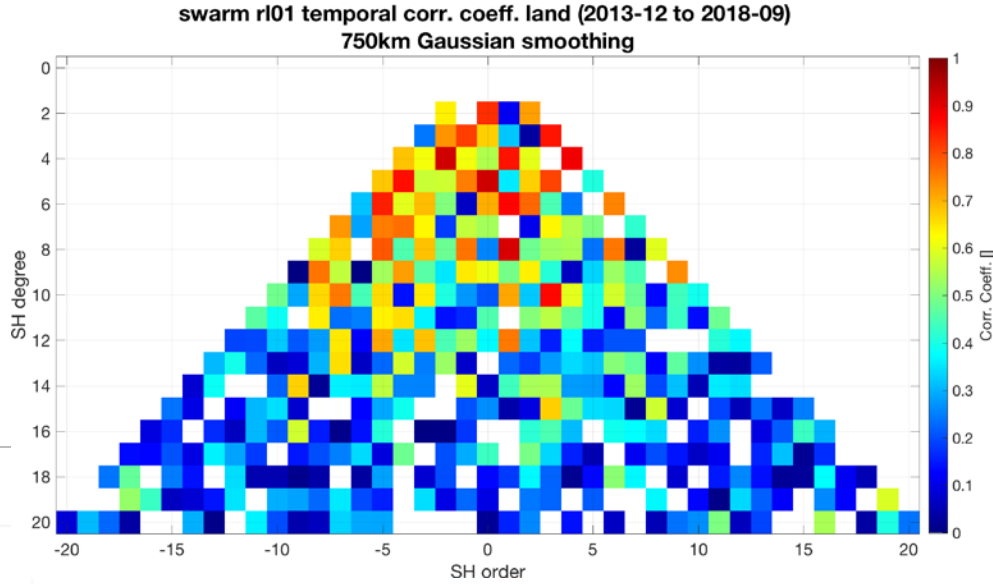

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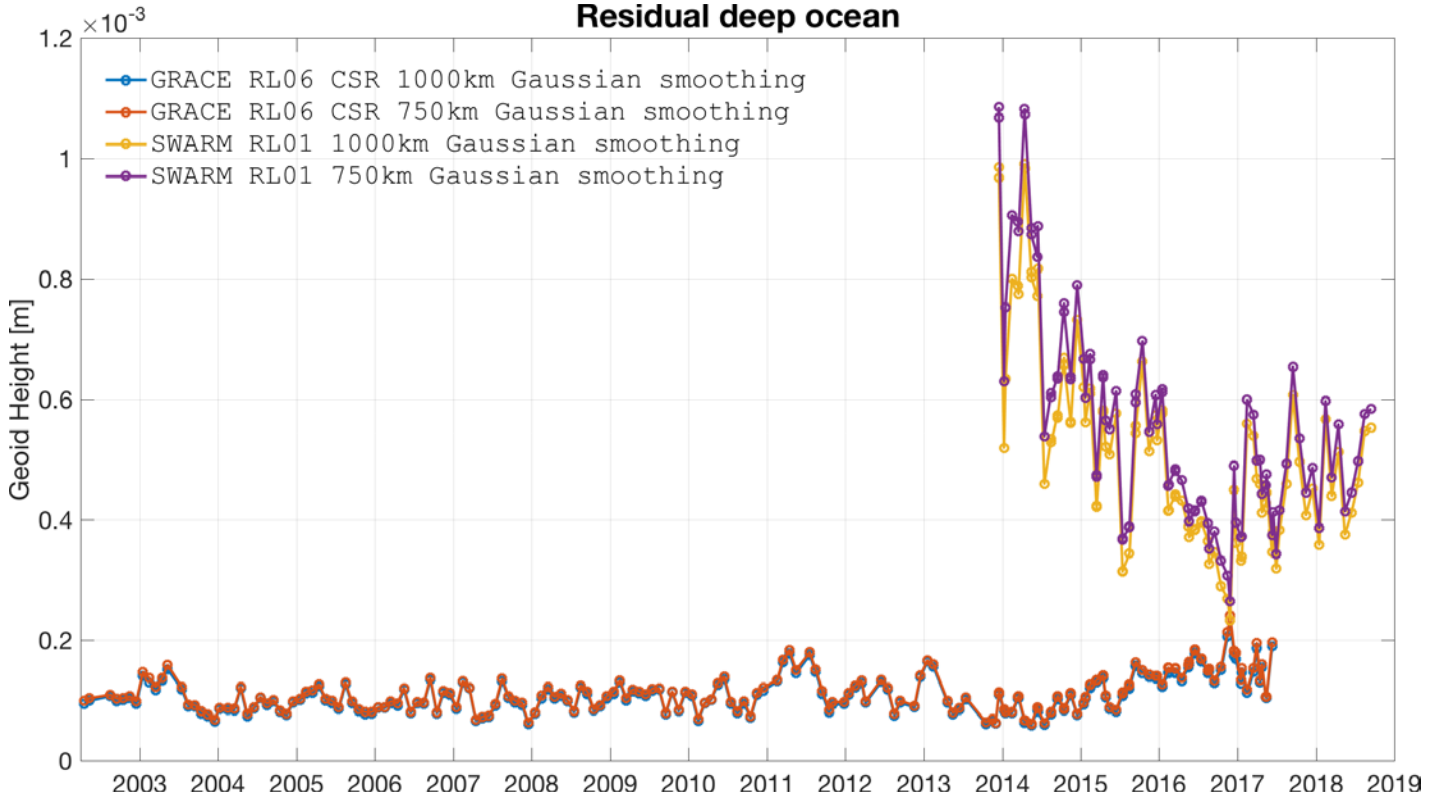
Swarm and Grace un-modeled ocean RMS



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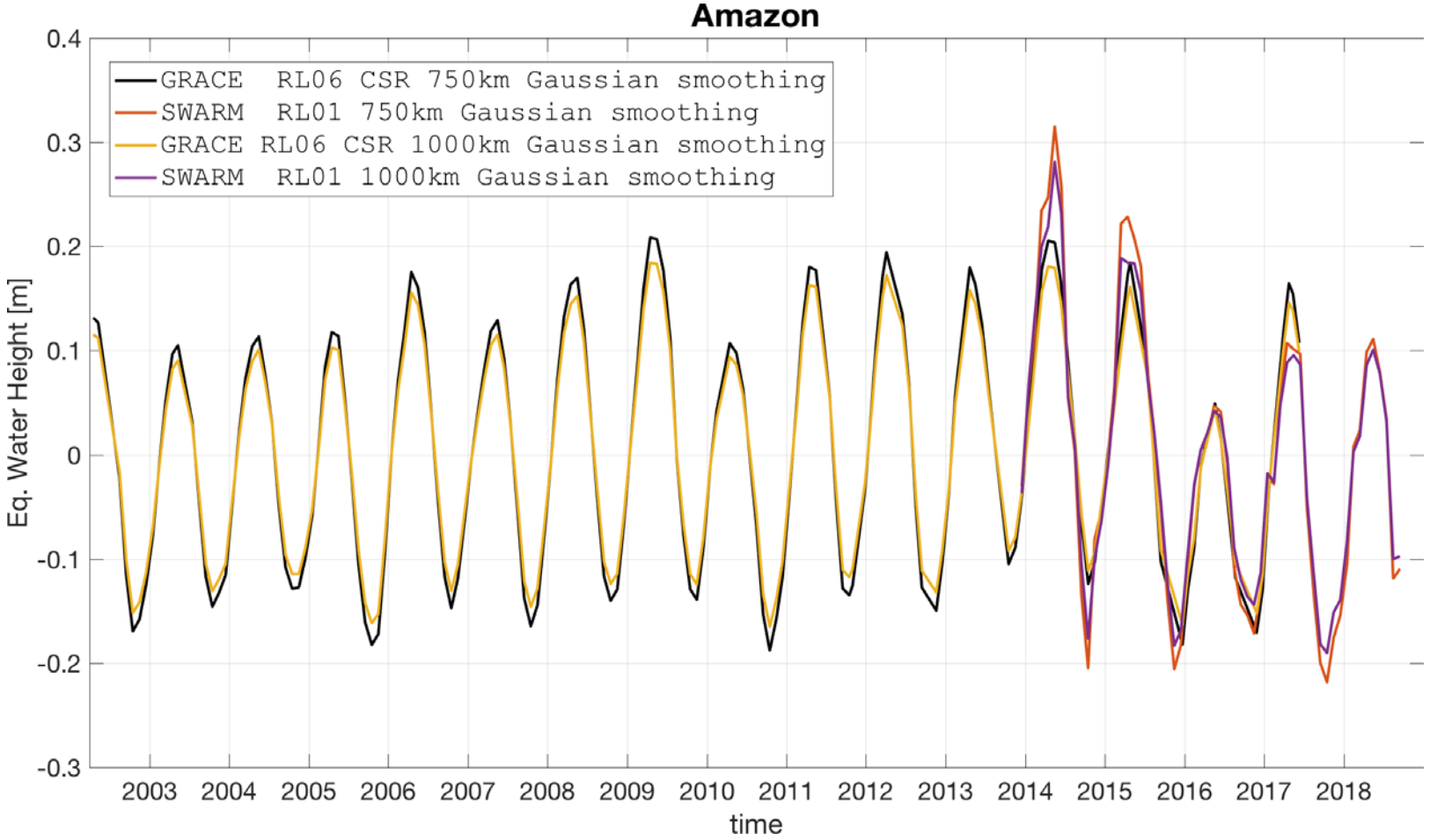

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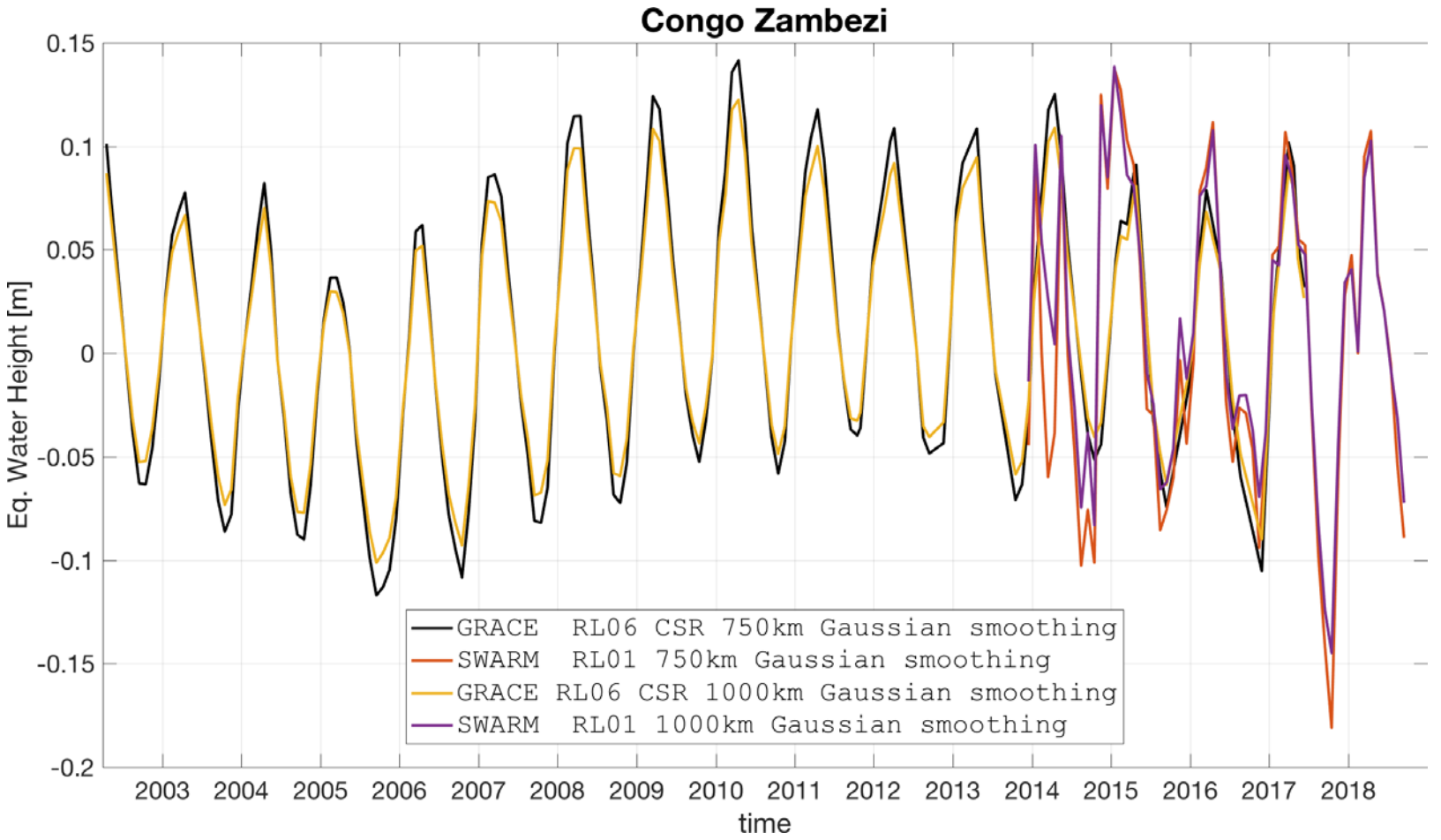

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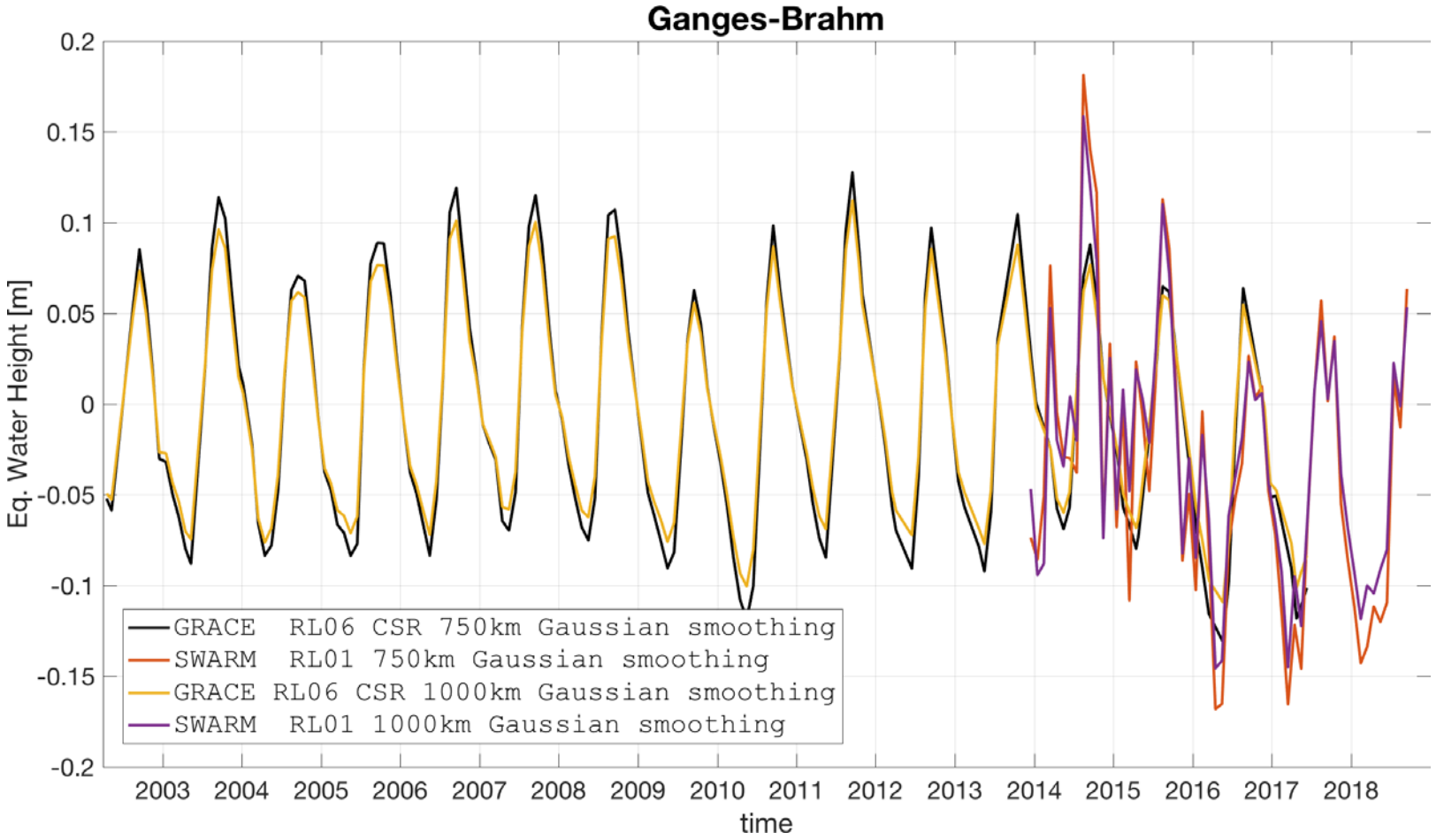

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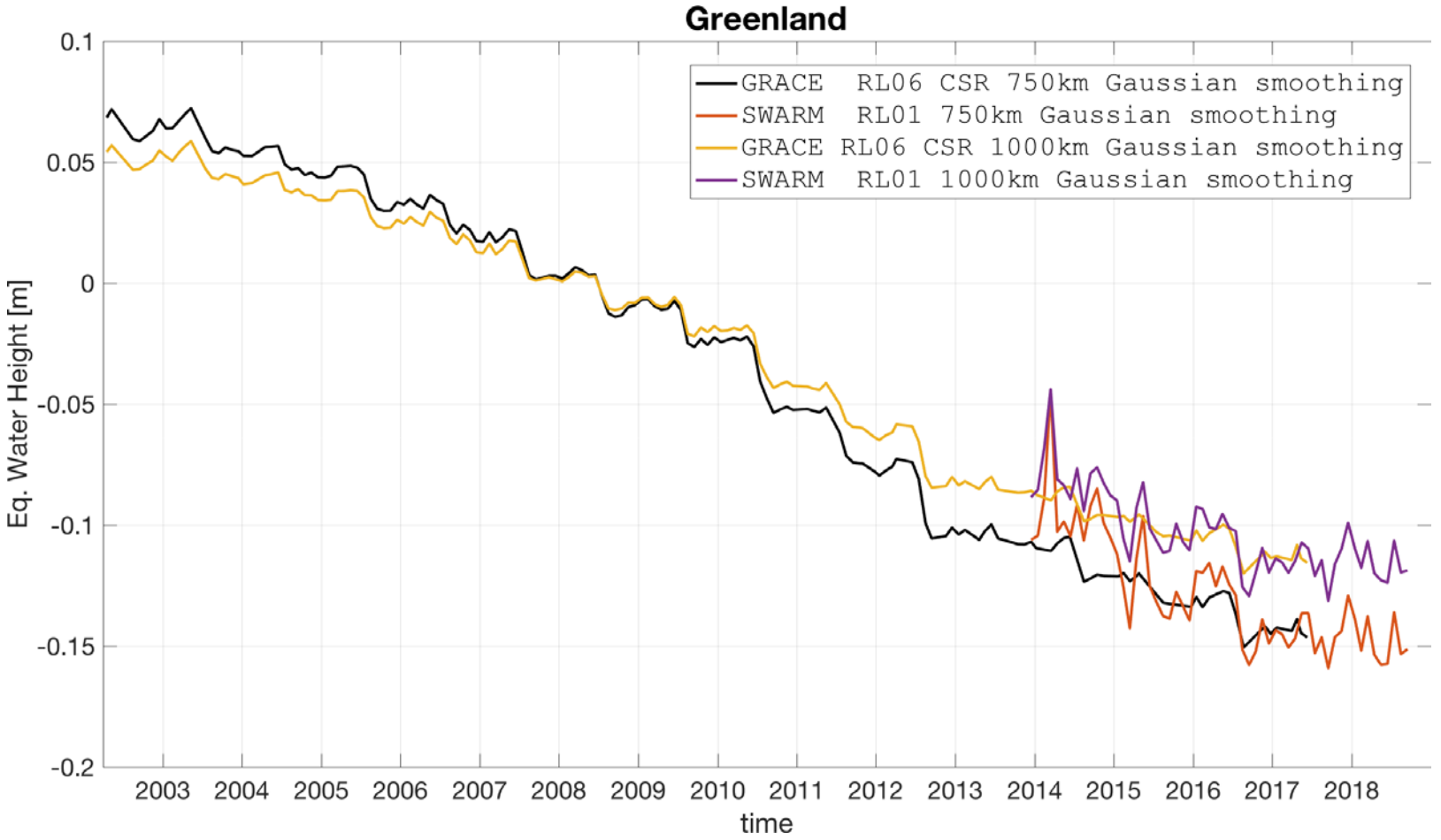

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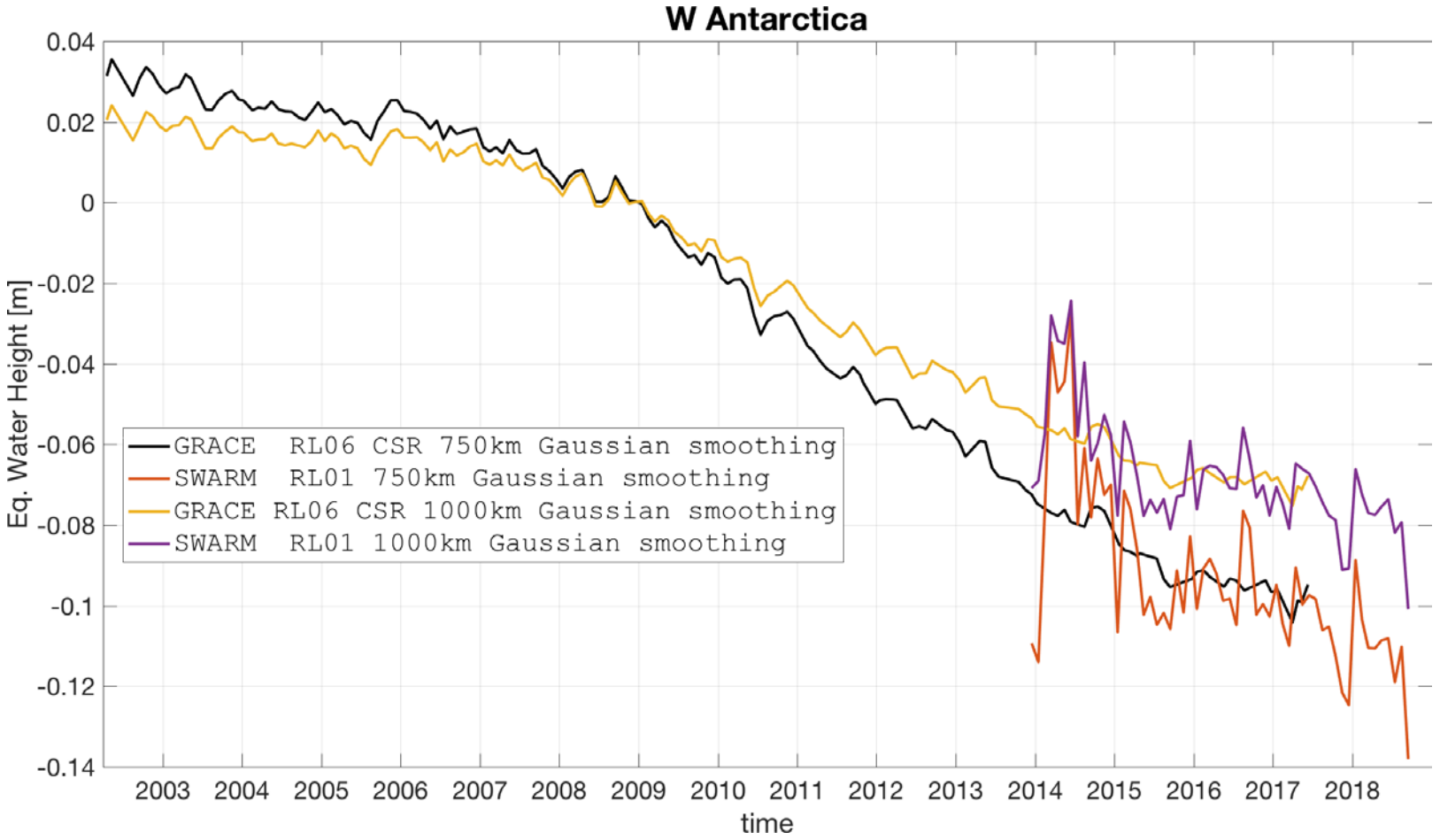

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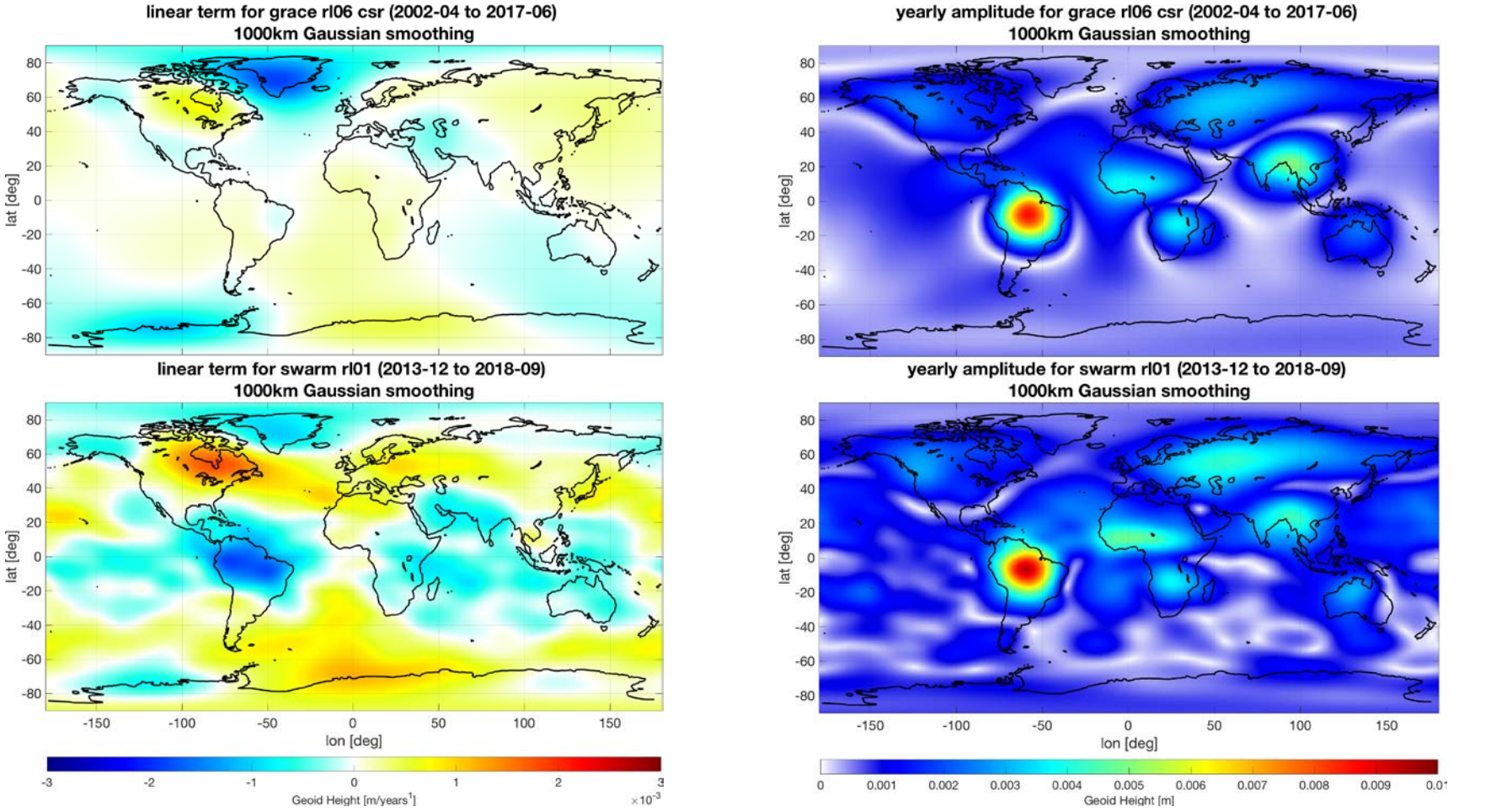

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Summary and conclusions

- Swarm signal useful below **degree 15**
- Temporal correlations decrease sharply over **degree 10**
- Swarm basin averages noisier than GRACE, except for largest basins
- Global spatial agreement with GRACE at **1 cm RMS** Eq. W. H.
  - over periods of low solar activity
  - Gaussian smoothing radius of 750 km
- **Seasonal signal** clearly resolvable by Swarm